REPORT

ON THE

Cawnpore Farm and other Experiment Stations

IN THE

UNITED PROVINCES

FOR THE YEAR ENDING JUNE 30TH, 1903.

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DEPARTMENT OF LAND RECORDS AND AGRICULTURE, UNITED PROVINCES.

Dated Cawnpore, the 26th of October 1903.

FROM

W. H. MORELAND, ESQ., I.C.S

DIRECTOR OF LAND RECORDS AND AGRICULTURE,

UNITED PROVINCES,

To

THE CHIEF SECRETARY TO GOVERNMENT

UNITED PROVINCES.

SIR,

I HAVE the honour to submit, for the information of Government, the report on the Cawnpore Farm and other experiment stations in the United Provinces for the year ending June 30th, 1903.

I have the honour to be,

SIR,

Your most obedient servant,

W. H. MORELAND,

Director.

Report on the Cawnpore Experimental Farm and other Experiment Stations for the year ending June 30th, 1903.

CHAPTER I.

Field experiments conducted at the Cawnpore Farm.

1.—HISTORY, &c.

THE farm is situated in the village of Gotaiya, about three miles from Cawnpore; it is within a few yards of the Rawatpur station on the Cawnpore-Achnera Railway, and at a distance of about four miles from the East Indian Railway and five miles from the Oudh and Rohilkhand Railway stations. The land occupied was originally rented from the land-holders and tenants of Gotaiya in 1881 and in that year the important manurial experiments still carried on in the "standard" and "duplicate" series, which will be described presently, were started by Mr. J. B. Fuller, then Assistant Director of this Department. The tenure of the land remained unaltered until the past year; changes in the tenancy law of the province had, however, rendered our tenure illegal in the case of several fields, and the ownership of the whole area has been acquired by Government.

During the early years of management the area of the farm underwent frequent changes; but of late it has not varied, and is 51·33 acres in extent, of which 36·34 acres are under cultivation and the rest is occupied with roads, watercourses, and farm buildings. Of the cultivated area about six acres consist of small corner plots or irregular fields, unsuitable for experimental work, and this area is utilized for raising fodder for the farm cattle. The whole area of the farm is irrigable from a distributary of the Ganges canal, and is thus well protected against seasons of drought or deficient rainfall.

The soil of the farm may be accepted as a fair sample of the light reddish alluvial loam which occurs over a large portion of the Ganges-Jumna Doáb. Though, according to the analyses made in 1882 by the late Mr. S. A. Hill, B.Sc., it contains 78·56 per cent. of insoluble sand, yet owing to the fineness of the particles its physical characters are those of a clayey loam. The soils of a good many plots of the farm have been analysed by the Agricultural Chemist to the Government of India, and the following table gives the composition of five unmanured plots as regards the three dominant agricultural ingredients (*vide* page 54, Agricultural Ledger No. 2 of 1898).

Composition of the soils of the unmanured plots of the Farm.

Name of plot.	Total nitrogen.	Total phosphoric acid.	Available phosphoric acid.	Available potash.
	Per cent.	Per cent.	Per cent.	Per cent.
Rabi standard, No. 11	·024	·085	·021	·012
Kharíf standard, No. 13	·016	·053	·022	·007
Alternate series A, No. 13	·017	·088	·030	·007
Alternate series B, No. 11	·023	·071	·014	·012
Green manure series, No. 5	·017	·053	·015	·027
Average	·019	·070	·020	·013

Chemical analysis and practical experience concur in showing that there is no abnormal deficiency of lime or any other plant-food ingredients.

2.—CHARACTER OF THE SEASON.

Vide Appendix I.

The season was not on the whole unfavourable. The monsoon set in on 15th June with light showers of rainfall followed by a break of about three weeks. During July the rain was sufficient for sowings, but in the month of August it was so deficient that the maize, sugarcane, and other kharíf crops suffered more or less; maize suffering the most. The rain in September proved very beneficial to the kharíf in general and facilitated the tillage for the rabi. The cold season was very dry, and, as usual, some slight damage was caused by rats and whiteants; but on the other hand fungoid diseases were not troublesome. The frost on 22nd and 26th December completely killed the cotton, and considerable damage was also done to the potato crop.*

3.—MANURIAL EXPERIMENTS.

The following manurial experiments were carried on during the past year :—

Name.	Crop.	Number of plots.	Area in acres.	Duration of experiments.
1. Kharíf standard ...	Maize (every year) ...	13	1·07	Permanent.
2. Rabi standard ...	Wheat (ditto) ...	13	1·07	
3. Duplicate or alternate series A.	Maize and wheat alternately.	13	1·07	
4. Ditto B ...	Ditto ...	13	1·07	
5. Green manuring and Rotation experiment.	Wheat	4	·70	
	Ditto ...	14	2 33	
6. Sugarcane series ...	Sugarcane ...	20	5·50	Closed this year.
7. Potato series ...	Potato	10	1·00	Ditto.
	Total ...	100	13·81	

Maize and wheat.—The first four experiments are carried on in four series of 13 plots each, *i.e.* on 52 plots in all. When originally started in 1881 by Mr. J. B. Fuller, there were only ten plots in each series, and the remaining three plots were subsequently added in 1882 and 1883. Since then there has been no change in the number of plots. One series is cropped every year with maize, another with wheat, and these two are called kharíf and rabi standard series respectively. In the other two series known as "alternate series" maize and wheat are grown in rotation in alternate years. Thus the maize crops on the kharíf standard plots get every year a fallow of about nine months, while those on the duplicate plots, a fallow of only about two months after the previous crops of wheat is cut. But as regards wheat the rabi standard plots get a fallow of six months against the 13 months on the duplicate plots. Owing to this reason the maize on the standard plots is, as a rule, better than on the duplicate plots, while the wheat on the alternate plots is better, though the difference is less marked and less certain than is the case with maize. The manure applied to one plot of the standard series is also applied to the corresponding plot of the duplicate series. The object of the kharíf and rabi standard series is to ascertain the effects and establish the relative values of certain manures on maize and wheat grown year after year on the same land. The object of the alternate series is to some extent to duplicate these trials and also to study the effects and economy of alternation of maize with wheat.

The scheme of treatment of these plots was changed four years ago at the instance of the Agricultural Chemist to the Government of India. The old and new schemes, as well as the compositions and quantities of manures applied during the year under report, are given in the next table.

* Appendix II (temperature) is not printed this year. The new thermometers were not received until the latter part of the year.

Table showing the old and new schemes of treatment and compositions and quantities of manures.

No. of plot.				Old treatment.	New treatment.	Composition and quantities of manures applied per acre in 1902-1903.			
						Maize.		Wheat.	
Rabi standard.	Alternate B.	Kharif standard.	Alternate A.			Percentage of nitrogen.	Quantity of manure applied.	Percentage of nitrogen.	Quantity of manure applied.
							lbs.		lbs.
R.3	3	K.3	6	Cattle manure @ 180 mds. per acre.	Cattle manure to supply 100lbs. nitrogen per acre.	·48	20,833	·538	18,587
R.4	4	K.1	7	Cattle manure and bonedust @ 4½ mds. per acre.	Cattle manure to supply 50lbs. nitrogen per acre.	·48	10,416	·538	9,293
R.5	5	K.2	8	Cattle manure and gypsum @ 3 mds. per acre.	No manure ...	...	...	...	...
R.6	6	K.10	1	Sheep-dung @ 180 mds. per acre	Sheep-dung to supply 100lbs. nitrogen per acre.	1·28	7,812	·765	13,072
R.8	8	K.7	10	Sheep-dung and bonedust @ 4½ mds. per acre.	Sheep-dung to supply 50lbs. nitrogen per acre.	1·28	3,906	·765	6,536
R.10	10	K.12	12	Sheep-dung and gypsum @ 3 mds. per acre.	Poudrette to supply 50lbs. nitrogen per acre.	·50	10,000	·498	10,040
R.12	12	K.9	2	Poudrette @ 180 mds. per acre.	Poudrette to supply 100lbs. nitrogen per acre.	·50	20,000	·498	20,080
R.1	1	K.5	4	Saltpetre @ 3 mds. per acre.	Saltpetre to supply 25lbs. nitrogen per acre.	11·51	217	11·51	217
R.2	2	K 11	5	Saltpetre and bonedust @ 4½ mds. per acre.	Saltpetre to supply 25lbs. nitrogen per acre. } 35lbs. nitrogen per acre.	11·51	217	11·51	217
					Bonedust to supply 10lbs. nitrogen per acre. } 35lbs. nitrogen per acre.	3·46	289	3·36	297
R.9	9	K.6	11	Saltpetre and bone-superphosphate, each @ 3 mds. per acre.	Saltpetre to supply 25lbs.: bone-superphosphate 10lbs. } 35lbs. nitrogen per acre.	11·51	217	11·50	217
						1·62	617	1·62	617
R.7	7	K.4	9	Ashes of 180 mds. of cow-dung per acre.	Ashes of 180 mds. of cow-dung per acre.	...	6,981	...	5,082
R.13	13	K.8	3	Ashes and saltpetre @ 3 mds. per acre.	Ashes and saltpetre to supply 25lbs. nitrogen per acre.	11·51	6,981 217	11·51	5,082 217
R.11	11	K.13	13	Unmanured ...	Unmanured ...	...	...	...	...

Maize.—The two series bearing maize were treated as follows:—

Ploughed twice, sub-soiled once, cultivated with the planet Jr. cultivator twice, and levelled with the *patela* four times. The manures were applied at one time in July, except saltpetre, which was applied as a top dressing in two instalments, on the 28th July and the 14th and 16th August. Seed was dibbled on the 11th and 12th July, in holes two feet by one foot apart from each other at the rate of three or four seeds to the hole to guard against contingencies of uneven germination; the rate of seed coming to about 24lbs. per acre. When the plants were about a week old the crop was thinned and blanks filled in, weeded, and hoed twice, earthed up once, and watered once.

The plants of all the plots suffered much from the deficiency of rainfall in the month of August, which caused ill development of cobs and affected the outturn a great deal. The crop was harvested on the 28th, 29th, and 30th September, and the next table gives the results of both the series for the past and the previous years.

Acreage outturns (in lbs.) of dry maize

Plot area.	Year.	Cow-dung at 100lbs. nitrogen per acre.		Cow-dung at 50lbs. nitrogen per acre.		Residue of cow-dung applied in previous years.		Sheep-dung at 100 lbs. nitrogen per acre.		Sheep-dung at 50lbs. nitrogen per acre.		Poudrette at 100lbs. nitrogen per acre.	
		Standard.	Alternate.	Standard.	Alternate.	Standard.	Alternate.	Standard.	Alternate.	Standard.	Alternate.	Standard.	Alternate.
Each plot is equal to 400 square yards.	* Average of five years, 1883 to 1886 and 1889.	1,211	1,119	1,442	1,114	1,261	1,006	876	1,003	1,285	880	1,255	1,282
	Average of five years, 1890 to 1894.	996	744	1,303	906	1,471	906	1,330	1,483	1,529	1,184	1,096	1,528
	1895 ...	2,018	1,004	1,900	1,110	2,105	1,140	2,668	1,189	2,344	1,186	1,945	2,027
	1896 ...	2,541	1,156	1,700	1,385	1,706	1,210	2,813	1,706	2,378	1,809	2,148	1,428
	1897 ...	3,158	2,989	3,243	1,422	3,424	2,452	3,733	1,972	3,025	3,633	3,527	1,794
	1898 ...	1,609	1,343	2,105	1,779	2,226	1,682	2,093	2,009	1,634	1,888	2,323	1,984
	1899 ...	1,634	1,701	2,136	1,331	2,202	1,579	2,393	1,246	2,707	1,516	2,426	2,490
	Average of five years, 1895 to 1899.	2,192	1,639	2,217	1,405	2,333	1,613	2,740	1,624	2,418	2,006	2,474	1,945
	1900 ...	2,698	2,420	3,064	2,641	3,167	2,426	2,989	2,605	3,228	2,559	2,940	2,892
	1901 ...	2,538	2,417	2,368	2,017	2,704	1,833	2,468	2,368	3,133	2,102	2,565	2,725
	1902 Grain ...	1,283	1,343	1,700	1,621	1,700	1,301	1,694	1,125	1,942	1,240	1,930	1,331
	1902 Straw ...	5,505	2,977	5,396	2,577	3,956	2,202	6,618	3,497	5,372	3,279	6,618	4,041

NOTES *(1)—The figures for single years from 1882—1894
(2)—The years 1887 and 1888 are excluded from the

grain in the standard and alternate series.

Poudrette at 50lbs. nitrogen per acre.		Saltpetre at 25lbs. nitrogen per acre.		Saltpetre at 25lbs. nitrogen and bone-dust at 10lbs. nitrogen per acre.		Saltpetre at 25lbs. nitrogen and bone-superphosphate at 10lbs. nitrogen per acre.		Ashes of 180 maunds of cow-dung per acre.		Ashes of 180 maunds of cow-dung and saltpetre at 25 lbs. nitrogen per acre.		No manure.		Remarks.
Standard.	Alternate.	Standard.	Alternate.	Standard.	Alternate.	Standard.	Alternate.	Standard.	Alternate.	Standard.	Alternate.	Standard.	Alternate.	
1,146	957	1,099	757	1,174	931	1,052	881	821	628	1,207	1,130	617	413	
1,367	1,067	794	778	899	952	1,212	872	682	683	1,276	984	695	570	
2,232	1,325	850	787	1,437	1,089	1,624	898	995	750	1,703	1,007	1,059	774	Alternate B.
2,035	2,021	1,119	714	1,065	430	877	375	1,349	607	910	853	472	200	Do. A.
3,225	2,372	2,544	2,228	2,695	2,493	2,816	1,410	2,411	2,133	2,713	2,015	2,021	1,857	Do. B.
2,396	2,105	1,295	1,222	2,614	1,309	1,888	1,162	1,210	956	2,033	1,730	1,307	460	Do. A.
2,420	2,045	1,997	717	2,329	1,125	1,945	1,237	1,664	871	2,169	1,773	1,476	1,177	Do. B.
2,462	1,974	1,561	1,134	2,028	1,289	1,830	1,016	1,526	1,063	1,906	1,476	1,267	894	
3,182	2,974	2,190	2,257	2,151	2,438	2,738	2,184	1,755	1,712	2,202	2,166	1,682	690	Do. A.
2,925	2,009	2,396	1,912	2,244	2,175	2,196	1,963	1,464	1,452	2,314	2,154	1,730	1,249	Do. B.
2,099	1,997	1,281	1,295	1,915	1,392	1,246	1,310	1,895	750	1,470	1,131	1,316	889	Do. A.
4,961	3,412	4,005	3,242	4,150	7,115	3,158	2,577	4,162	3,219	3,388	2,444	3,049	1,779	

will be found in the report for 1900–1901.

average as the crops were almost entire failures.

Wheat.—The two series bearing wheat were treated as follows: Ploughed four times, sub-soiled once, spread on 17th and 18th October 1902, except saltpetre, which was applied in two instalments, on 13th 23rd October at the rate of about 133 lbs. per acre and the land levelled. The crop was weeded once, given in the following table:—

Acreage outturns (in lbs.) of wheat grain

Plot area.	Year.	Cow-dung at 100lbs. nitrogen per acre.		Cow-dung at 50lbs. nitrogen per acre.		Residue of cow-dung applied in previous years.		Sheep-dung at 100lbs. nitrogen per acre.		Sheep-dung at 50lbs. nitrogen per acre.		Poudrette at 100lbs. nitrogen per acre.	
		Standard.	Alternate.	Standard.	Alternate.	Standard.	Alternate.	Standard.	Alternate.	Standard.	Alternate.	Standard.	Alternate.
Each plot is equal to 400 square yards.	Average for five years, 1885 to 1889.	1,184	1,394	1,338	1,339	1,258	1,361	1,219	1,517	1,051	1,511	1,253	1,642
	Average for six years, 1890 to 1895.	1,613	1 743	1,685	1,606	1,560	1,581	1,691	1,690	1,694	1,954	1,653	1,792
	1896	2,765	2,184	2,910	1,900	2,904	250	3,001	3,120	3,206	3,104	2,819	3,092
	1897	2,558	2,729	2,472	2,553	2,558	2,716	2,967	2,868	2,107	2,777	2,889	3,219
	1898	2,384	2,202	2,880	2,239	2,069	2,021	2,543	2,880	2,396	2,565	2,202	2,372
	1899	2,184	2,505	2,363	2,384	2,166	2,217	2,505	2,741	2,232	3,028	2,245	2,356
	1900	2,729	2,795	2,937	2,456	2,659	2,229	3,089	3,004	2,741	2,816	2,490	2,598
	Average for five years, 1896 to 1900.	2,524	2,483	2,712	2,306	2,471	2,339	2,821	2,923	2,536	2,858	2,529	2,727
	1901	1,485	1,906	1,652	2,021	1,337	1,960	1,797	1,688	1,431	1,936	1,367	1,676
	1902	2,565	3,031	2,686	2,952	2,450	2,426	2,075	2,396	2,414	3,037	2,166	2,608
	1903 Grain ...	2,595	3,243	2,493	2,704	2,456	2,771	3,061	2,698	2,813	3,606	2,184	3,285
	1903 Straw ...	4,035	5,651	5,457	5,064	4,126	6,171	5,844	4,671	4,919	6,522	5,832	6,467

NOTES * (1)—About a third of this plot has the disadvantage of
(2)—The figures for 1883 and 1884 are purposely left out
(3)—The figures for single years, from 1885—1895, will

cultivated twice with the planet Jr. cultivator, and levelled five times with the *patah*. The manures were November 1902 and 30th December 1902, as a top dressing. The seed was sown with the country plough on watered thrice, and harvested on 10th to 12th April. The results of the last and of the previous years are

in the standard and alternate series.

Poudrette at 50lbs. nitrogen per acre.		Saltpetre at 25lbs. nitrogen per acre.		Saltpetre at 25lbs. nitrogen and bone-dust at 10lbs. nitrogen per acre.		Saltpetre at 25lbs. nitrogen and bone-superphosphate at 10lbs. nitrogen per acre.		Ashes of 180 maunds of cow-dung per acre.		Ashes of 180 maunds of cow-dung and saltpetre at 25lbs. nitrogen per acre.		No manure.		Remarks.
Standard.	Alternate.	Standard.*	Alternate.	Standard.	Alternate.	Standard.	Alternate.	Standard.	Alternate.	Standard.	Alternate.	Standard.	Alternate.	
1,177	1,325	1,314	1,406	1,398	1,726	1,131	1,557	829	1,246	1,208	1,405	888	1,082	
1,797	1,874	1,481	1,573	1,484	1,748	1,681	1,704	1,339	1,448	1,568	1,731	1,104	1,308	
3,146	2,983	1,839	2,353	2,063	1,516	2,426	1,927	2,202	2,090	2,396	2,408	2,257	1,183	Alternate A.
2,466	2,952	1,853	2,535	1,948	2,589	2,236	2,559	1,757	1,785	2,188	2,474	1,723	1,936	Do. B.
2,263	2,553	1,851	2,045	2,154	2,263	2,468	2,360	1,742	1,307	1,827	2,142	1,416	1,246	Do. A.
2,680	2,898	2,242	2,608	2,287	2,689	2,360	2,602	1,851	1,761	1,567	1,597	1,386	1,658	Do. B.
3,004	2,952	2,323	2,768	2,420	2,592	2,961	2,704	2,154	1,779	2,251	2,444	1,951	1,500	Do. A.
2,712	2,868	2,022	2,462	2,174	2,330	2,490	2,430	1,941	1,744	2,046	2,213	1,747	1,505	
1,434	1,588	1,077	2,118	1,379	1,960	1,621	1,821	1,071	1,473	1,506	1,900	1,189	1,410	Do. B.
2,719	2,810	2,220	2,577	2,205	2,668	2,650	2,771	2,353	2,565	2,323	2,335	1,936	1,724	Do. A.
2,305	3,285	1,773	2,502	2,093	2,045	3,025	2,910	1,894	2,118	2,066	2,886	2,366	1,969	Do. B.
5,433	5,270	3,781	4,250	4,138	6,534	4,852	6,419	3,346	3,267	3,125	4,362	2,414	2,968	

adjoining trees, and bears every year a strikingly poorer crop than the rest of the plot.
of account.
be found in the report for 1900-1901.

Experiments included under nitrogen investigations.

As mentioned in last year's report, the green-manuring and rotation experiments have been revised; four of the green-manuring plots have been retained, and a number of rotation plots laid out close to them.

The scheme of the experiment, which was fully discussed with the Inspector-General of Agriculture, now stands as follows :—

(*A*) *Two-year rotations.*

Two plots.—Wheat and gram in alternate years.
Two plots.—Wheat and *juár-arhar* in alternate years.
One plot.—Wheat and *jurá-urd-lubia* in alternate years.
Two plots.—Wheat and *juár* in alternate years.
One plot.—Wheat every year.
One plot.—Wheat and mustard every year.
One plot.—Wheat-gram every year.

(*B*) *Dofasli rotations.*

One plot.—Wheat after hemp removed.
One plot.—Wheat after *urd*-fodder removed
One plot.—Wheat after *khurti*-fodder removed.
One plot.—Maize followed by wheat in the same year.

(*C*) *Green manuring.*

Wheat after hemp ploughed in.
Wheat after *khurti* ploughed in.
Wheat after *urd* ploughed in.
Wheat every year.

WHEAT.

Details of cultivation.—In the kharíf, the *juár* plots were ploughed twice, cultivated once, and levelled twice: the maize plot was ploughed once, cultivated once and levelled twice; the remaining plots were ploughed and levelled once. The *juár* plots were sown on July 28th, the others between July 13th and 16th. All were sown broadcast except the maize, which was dibbled by hand.

The standing green manures were ploughed in on August 23rd, the green plants in the *dofasli* group were removed on August 30th. The *juár* plots were weeded once, the maize plot was weeded twice, earthed once, and watered once, during the long break. In the rabi all plots were ploughed five times and cultivated twice: levellings varied from four to seven according to the needs of the plot. Seed was sown on October 24th and 25th, and all plots weeded once. The wheat plots were watered three times, the gram once.

The outturns are given in the following table :—

ROTATION AND GREEN MANURING EXPERIMENT.

Outturns in pounds per acre 1902-1903.

Field No.	Area.	Crop.	Outturn. Kharif.	Outturn. Rabi.	Remarks.
		(A) Two-year rotations.			
31—33/1	1/6th acre.	Wheat (after gram) ...	...	3,546	
31—33/2	„	Gram (after wheat) ...	...	1,485	
31—33/4	„	Wheat (after *juár-arhar*) ...	...	2,562	
31—33/3	„	*Juár-arhar* (after wheat) ...	*Juár* 387 *Arhar* 606	...	
31—33/10	„	*Juár-urd-lubia* (after wheat)	*Juár*—390 *Urd*—30 *Lubia*—12	...	*Lubia* outturn was diminished by thefts of pods.
31—33/12	1/6th acre.	*Juár* (after wheat)... ...	402	...	
31—33/13	„	Wheat (after *juár*) ...	...	2,076	
31—33/5	„	Wheat (every year) ...	...	2,733	
31—33/9	„	Wheat and mustard (every year),	...	Wheat 1,949 Mustard 411	Wheat was badly laid.
31—33/11	„	Wheat-gram (every year) * ...	...	...	
		(B) Dofasli rotations.			
31—33/6	„	Wheat (after hemp) ...	11,088	2,259	
31—33/7	„	Wheat (after *urd* fodder) ...	8,400	1,692	
31—33/8	„	Wheat (after *khurti* fodder) ...	6,888	1,341	
31—33/14	„	Maize and wheat * ...	...	...	
		(C) Green manuring plots.			
27*a*/1	778 square yards.	Wheat (after hemp) ...	...	980	
27*a*/2	„ ...	Wheat (after *khurti*) ...	...	818	
27*a*/3	940 square yards.	Wheat (after *urd*)... ...	...	835	
27*a*/4	890 square yards.	Wheat...	...	481	

* The plot first assigned to these crops turned out to be very defective and has now been changed. The outturns are therefore not given.

Manurial experiment with sugarcane.

This experiment was started in 1896 by the Agricultural Chemist to the Government of India. The variety of sugarcane tried is the chewing form known in these provinces as "*Madrasi*". As the crop occupies the land for about 11 months, two sets of ten plots each have been allotted for the purpose in two different parts of the Farm; ten plots on field Nos. 29 and 30 and the other ten plots on Nos. 37, 38, and 39. These two sets are sown with sugarcane in alternate years; and in order to work out the manure residue each series bears an unmanured intermediate crop. Until 1899 potatoes were sown for this purpose, but since that year a rain cereal, *sanwan* (*Panicum frumentaceum*), a cheaper and easier crop to grow, has been substituted. The plots suffered badly from the borer and also from white-ants, so that in nearly every plot many of the sets failed to germinate.

The growing of sugarcane so constantly on the same land with the plentiful supply of manure and heavy waterings has resulted in the weed *motha* becoming particularly troublesome, springing up almost as fast as it is weeded and the intermediate rain cereal, *sanwan*, though growing thickly, seems to have no practical value as a smothering crop under such circumstances.

Details of cultivation.—After cutting the *sanwan* crop the plots in fields Nos. 37, 38, and 39 were ploughed twice, sub-soiled once, cultivated twice, and levelled five times. Manures were applied on different dates in the month of February 1902 except bone-superphosphate, part of which was applied in the month of February and part in May 1902. On the 19th to 25th February selected cuttings were planted as usual on the ridge and furrow system, the ridges being 30 inches apart. The crop was irrigated 14 times in all, weeded thrice, dug once, and earthed up once.

The harvesting of the series began on the 5th January and continued up to the 25th January 1903.

Results obtained with several manures applied to sugarcane, 1902-1903.

Plot No.	Plot area.	Treatment.	Actual quantities of manure applied per acre.	Outturn per acre.			Percentage.		
				Cane.	Juice.	Gur.	Juice to cane.	Gur to juice.	Gur to cane
			lbs.	lbs.	lbs.	lbs.			
37, 38, & 39 1	Each plot 968 square yards.	Cow-dung at 125lbs. nitrogen per acre.	25,510·2	12,020	7,230	1,070	60·14	14·79	8·90
37, 38, & 39 2		Ditto 250 ditto	51,020·4	16,430	8,710	1,145	53·01	13·14	6·96
37, 38, & 39 3		Ditto 500 ditto	1,02,040·8	6,850	4,610	630	67·29	13·66	9·19
37, 38, & 39 4		Poudrette at 250 ditto	54,347·82	5,950	3,310	490	60·73	14·80	8·99
37, 38, & 39 5		Ditto 500 ditto	1,08,695·64	16,940	10,155	1,795	59·82	17·67	10·59
37, 38, & 39 6		Saltpetre and superphosphate each at 125lbs. nitrogen per acre.	1912·23 & 5,000	15,735	9,625	1,370	61·16	14·23	8·70
37, 38, & 39 7		Saltpetre and bone-dust each at 125lbs. nitrogen per acre.	1,104·24 & 3731·34	8,650	4,920	695	56·87	14·12	7·10
37, 38, & 39 8		Castor-cake at 250lbs. nitrogen per acre.	3,703·7	8,960	5,380	790	60·04	14·68	8·81
37, 38, & 39 9		Ditto 500 ditto	7,407·4	17,495	9.990	1,650	57·12	16·51	9·43
37, 38, & 39 10		Unmanured	...	3,320	1,670	230	50·30	13·77	6·92

NOTE.—This year, after applying the bone-superphosphate, it turned out on analysis to contain only ·64 per cent. nitrogen in place of about 3 per cent. nitrogen which the superphosphate applied in previous years used to contain. It was quite impossible to make up so great a deficiency by applying more superphosphate as has been usually the custom in any slight fractional shortage (by the arrangement of the application it can never exceed quantity desired), consequently the deficiency of nitrogen was made up by applying saltpetre.

The next table shows the outturns in *gur* obtained in each year of the experiment and the average for the whole period. The results deducible from the experiment, which is now closed, will be discussed in a bulletin published separately.

Acreage yield of gur obtained with several manures applied to sugarcane (Madrasi paunda).

Treatment.	Years.							Average of seven years.
	1897.	1898.	1899.	1900.	1901.	1902.	1903.	
	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.
Unmanured	3,633	4,760	800	3,198	3,290	778	230	2,384
Cow-dung at 125lbs. nitrogen per acre.	4,830	4,528	4,853	4,432	4,325	1,032	1,070	3,581
Cow-dung at 250lbs. nitrogen per acre.	4,347	6,328	5,706	4,496	4,195	2,015	1,145	4,033
Ditto 500 do. ...	1,997	6,040	2,858	5,066	3,680	3,016	630	3,327
Poudrette at 250 do. ...	2,280	5,296	2,295	5,784	3,525	2,256	490	3,132
Ditto 500 do. ...	2,220	5,008	3,461	6,418	3,322	2,844	1,795	3,581
Saltpetre and superphosphate each at 125lbs. nitrogen per acre.	*	4,648	2,548	1,868	4,845	2,422	1,370	2,950
Saltpetre and bone-dust each at 125lbs. nitrogen per acre.	2,372	4,616	2,165	5,790	3,980	1,355	69[illegible]	2,996
Castor-cake at 250lbs. nitrogen per acre.	3,426	5,656	1,848	5,682	3,666	1,904	790	3,282
Ditto 500 do. ...	5,311	4,912	2,640	7,826	3,835	2,608	1,6[illegible]	4,112

*This plot began to be treated in 1898.

Manurial experiment with potatoes.

This experiment was started at the instance of the Agricultural Chemist to the Government of India in 1896. The variety grown is the common white skinned country variety known locally as *Madrasi*. The scheme of the manurial treatment continued the same as in the previous year. The manures are applied before planting potatoes; and with a view to work out the manure residues and to secure the most economical results possible for the expenditure incurred on the manures, a crop of maize is also grown in the interval between two crops of potatoes, without any other application of manure.

Details of cultivation.—Ploughed twice, sub-soiled once, cultivated once, and levelled four times. Manures were spread on 27th-28th October and 3rd November 1902. Whole tubers were planted in lines 30 inches apart, the holes in the lines being about 10 inches apart. After planting ridges were made along these lines by throwing earth with *pharuas*, from both sides. The crop was earthed up once, watered five times, and dug on the 13th to 17th February 1903.

The outturns are given in the next table; the experiment is now closed, and the results will be discussed in a separate publication.

Acreage outturns of potatoes and maize grown with different manures.

Plot No.	Plot area.	Manure applied per acre.	Actual quantities of manure applied per acre in 1902-1903.	Potatoes.								Maize.						
				1896-97.	1897-98.	1898-99.	1899-1900.	1900-1901.	1901-1902.	1902-1903.	Average of seven years.	1897.	1898.	1899.	1900.	1901.	1902.	Average of six years.
			lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.
25	Each plot=484 square yards.																	
1		Unmanured ...	...	9,830	6,500	7,860	13,710	6,915	7,090	2,910	7,831	3,130	1,920	1,100	2,720	1,625	1,200	1,949
25																		
2		Poudrette at 200lbs. nitrogen per acre.	40,160·64	7,720	11,640	8,540	22,250	16,870	19,830	7,495	13,478	3,490	2,740	2,153	3,680	2,460	1,460	2,664
25																		
3		Poudrette at 100lbs. nitrogen per acre.	20,080·32	5,700	9,730	9,170	17,070	12,365	13,390	6,755	10,597	3,265	2,440	1,733	3,690	2,315	1,380	2,471
24																		
4		Cow-dung at 200lbs. nitrogen per acre.	47,058·82	9,730	9,130	8,870	20,460	15,940	15,820	14,660	13,516	3,038	2,390	1,170	2,580	2,550	1,465	2,199
24																		
5		Cow-dung at 100lbs. nitrogen per acre.	23,529·41	9,260	7,340	9,140	15,910	9,775	9,910	11,850	10,455	2,955	1,720	1,030	2,965	2,325	1,350	2,058
24																		
6		Castor-cake at 200lbs. nitrogen per acre.	2,962·96	4,740	9,410	12,170	18,630	22,530	13,740	11,910	13,305	2,693	1,570	1,280	2,760	1,860	890	1,842
24																		
7		Castor-cake at 100lbs. nitrogen per acre.	1,481·48	8,430	10,280	11,610	15,100	15,010	10,750	13,300	12,069	2,533	1,910	1,240	2,780	1,995	935	1,899
26*b*																		
8		Saltpetre and bone-dust each at 50lbs. nitrogen per acre.	471·69 / 1,488	7,960	9,200	13,500	16,920	10,180	8,620	10,570	10,993	2,958	2,170	1,705	2,870	2,367	1,530	2,267
26*b*																		
9		Saltpetre at 50lbs. nitrogen per acre.	471·69	6,780	10,000	7,160	15,760	11,830	9,090	10,490	10,159	3,043	1,980	1,260	2,820	3,440	840	2,231
26*b*																		
10		Unmanured ...	...	4,080	8,160	2,900	9,820	5,470	4,560	5,030	5,717	3,005	1,840	988	2,380	1,890	1,150	1,876
		Average of the two unmanured plots.	...	6,955	7,330	5,380	11,765	6,193	5,825	3,970	6,774	3,068	1,880	1,044	2,550	1,758	1,175	1,913

TRIALS OF DIFFERENT VARIETIES OF CROPS.

Sugarcane varieties.—This experiment was started in 1896 at the instance of the Agricultural Chemist to the Government of India. Six varieties are under trial with large quantities of manure. Three of these known respectively as *Saharanpuri*, *Madrasi*, and *Poona* varieties, are usually grown by cultivators for consumption as fruit, but at the Farm they are experimentally used for the manufacture of sugar. The other three varieties are *dikchan*, *dhaul* and *matna*, all of which are important local varieties. These three are grown in single plots, each receiving poudrette at 250lbs. nitrogen per acre. The thicker canes are grown in two series, one receiving 250lbs. nitrogen and the other 500lbs. nitrogen per acre. As the crops can only be sown once in two years on the same plot, there are in all 18 plots covering an area of 1·75 acres. During alternate seasons a crop of *sanwan (Panicum frumentaceum)* is taken to work out the manurial residues.

Details of cultivation.—Ploughed thrice, sub-soiled once, cultivated twice, and levelled four times. The manures were applied on the plots treated with 500lbs. nitrogen per acre on the 11th and 12th February, and on those which received 250lbs. per acre on the 12th and 13th February 1902. Cuttings were planted on the 17th and 18th February 1902, as usual, on the ridge and furrow system with ridges 30 inches apart. The crop was weeded thrice, dug once and earthed up once. The varieties receiving 500lbs. nitrogen per acre were watered 12 times and those receiving 250 lbs. nitrogen 14 times. Cutting and crushing began on the 10th January and finished on the 31st January 1903. The results of the experiment are given in the next table. The crops were poor all round, being affected in the same way as those in the manurial experiment.

Results of the two variety experiments of sugarcane for 1902-1903.

Field number.	Plot area.	Treatment.	Actual quantity of manure in lbs. applied per acre.	Name of variety.	Outturn per acre.			Percentage of—			Remarks.
					Canes.	Juice.	Gur.	Juice to cane.	Gur to juice.	Gur to cane.	
					lbs.	lbs.	lbs.				
A. B. plots and field No. 12.	Each plot = 400 square yards.	Poudrette at 500lbs. nitrogen per acre.	108,696	*Madrasi.*	25,168	15,75·42	2,360	62·596	14·976	9·37	
		Ditto ...	108,696	*Saharanpuri.*	13,576	6,655	1,065	49·01	16	7·84	
		Ditto ...	108,696	*Poona*	17,303	9,511	1,428	54·96	15·01	8·25	
10 and 11.	Each plot = 605 square yards.	Poudrette at 250lbs. nitrogen per acre.	54,348	*Saharanpuri.*	...	...	...	...	...	...	Not crushed, being very poor.
		Ditto ...	54,348	*Madrasi.*	7,264	4,192	608	57·70	14·50	8·37	
		Ditto ...	54,348	*Poona*	11,008	7,120	1,008	64·68	14·15	9·15	
		Ditto ...	54,348	*Dikchan.*	24,746	13,920	2,357	56·25	16·93	9·52	
		Ditto ...	54,348	*Dhaul*	28,228	15,477	2,357	54·71	15·23	8·33	
		Ditto ...	54,348	*Matna.*	28,075	15,317	2,251	54·55	14·69	8·01	

Potatoes.—The three varieties under trial are (1) *Madrasi* white, (2) country red, and (3) Hill variety.

Details of cultivation.—Tillage.—Ploughed twice, sub-soiled once, cultivated once, and levelled four times. *Poudrette* at 200lbs. nitrogen per acre was applied on 28th October 1902. On 6th and 7th November 1902 whole tubers for the two country varieties and cut sets and whole tubers of the hill variety were dibbled in holes made with *khurpis* in regular lines on the flat ground. These lines were subsequently made into ridges by throwing earth over them. The distance between the ridges for the *Madrasi* was 20 inches apart and between the holes in the row 10 inches, while for the country and hill varieties the rows were 21 inches apart and the seed in the rows one foot apart. The weight of the seed used for the *Madrasi* variety came to 888lbs. per acre, that for the red variety to 412lbs., and that for hill variety to 1,360lbs. The crop was earthed up once, watered five times and harvested on different dates between 31st March and 3rd May 1903.

It was observed that the leaves of the country red potato were not affected by the frost while the plants of the other varieties were withered, but the tubers of the red potato did not develope fully and the outturn was therefore very low. The following statement gives the outturns obtained :—

Plot number.	Plot area.	Name of variety.	1898-99.	1899-1900.	1900-1901.	1901-1902.	1902-1903.
			lbs.	lbs.	lbs.	lbs.	lbs.
26A/1	Each plot = 1,210 square yards.	*Madrasi* white...	12,928	16,660	16,152	10,908	13,808
26A/2		Country red ...	11,772	19,700	17,312	11,300	5,512
26A/3		Hill variety ...	10,016	11,488	16,596	5,780	4,304

Regarding the difference of time in germination remarked on in last year's report the earliest sprouts of the *Madrasi* were noticed on the 13th day after planting, those of the red country on the 19th day, and those of the hill variety on 23rd day.

Cotton.—The trials of foreign varieties of cotton were continued during the year under report.

Details of cultivation.—The land was ploughed twice, sub-soiled once, cultivated once, and levelled four times. Cow-dung at 200 maunds per acre was applied on the 8th July 1902. Seed was dibbled on the 15th July 1902 in holes two feet apart, along the lines made in the fields at the intervals of two feet. The weaker and unhealthy looking plants were pulled out about ten days after sowing and the blank spaces were filled in by fresh sowing.

The crop was weeded twice and intercultured once with the country plough. Picking began in October and closed about the end of January.

The results of the past year and the previous years since 1895 are given in the following table. Two varieties of cotton, Sea Island and Upland, received from the United States, and Dales Egyptian cotton were also sown in small patches of ground; but their outturn need not be given at present as they are not acclimatised.

Acreage outturn in lbs. of clear fibre from different varieties of cotton.

Name of variety.	1895.		1896.	1897.	1898.	1899-1900.		1900-1901.	1901-1902.		1902-1903.	
	First crop.	Second crop.				First crop.	Second crop.	First crop.	First crop.	Second crop.	First crop.	
											Fibre.	Seed.
Wattagodu ...	...	...	...	...	86	300	300	224	259	217	123	350
Allen ...	...	...	...	...	29	248	156	201	266	147	88	231
Cook's long staple	...	...	...	...	67	219	300	74	125	150	109	242
Cawnpore Farm Variety No. 1	310	223	217	176	304	308	260	340	285	260	144	347
Hybrid ...	289	195	285	150	249	348	300	317	325	330	126	333
Cawnpore country ...	...	...	411	80	221	228	290	336	258	138	46	151

Cotton suffered this year severely from insect pests, and there was no second crop as all the plants were killed by the exceptional frost in December. It is worth noticing that the country variety suffered proportionately more than the imported.

Tapioca.—Two kinds of Tapioca (Travancore and Tanjore) were planted last year. The plants were not dug in the year under report, but will be allowed to grow for two or three years.

Juár.—A large number of *juárs* (supposed varieties) grown in different districts of these provinces and some of the best from neighbouring provinces have

been grown in the Farm in small plots kept separate to prevent cross-fertilization. Many of the supposed "varieties" have turned out to be identical, and good progress has been made towards determining the varieties actually existing in the provinces.

Maize.—Two common North Indian varieties and four American varieties were cultivated and kept under observation. This year these varieties were grown in plots as last year, separated by wider spaces with *juár* between to guard against natural cross-fertilization.

Kabuli gram.—During the last five years this crop has been cultivated on a small area with the object of studying its habits and characters as compared with the ordinary gram, and of raising a small quantity of seed for supply to the public. The grain is white, larger, fuller, and smoother, and presents a more attractive appearance than the ordinary gram. The plants also are larger and bushy with larger leaves and white flowers and with the roots better provided with tubercles than even the country gram which is one of the best of our crops in this respect. So far, however, the variety appears to be deficient in grain-yielding power as compared with the country kind. The year's outturn is shown in the following table :—

Acreage outturns of Kabuli and country grams for 1902 *and* 1903.

Plot number.	Plot area.	Crop.	Outturn per acre.	
			Grain.	Haulm.
			lbs.	lbs.
26B/1	Each plot = 484 square yards.	Country gram ...	1,045	1,175
26B/4		Kabuli gram ...	630	1,030
26B/5		Country gram ...	890	1,230

Sugarcane.—Besides the six varieties already noticed as being under systematic trial, eighteen varieties of thin canes grown in these provinces and two varieties of thick canes (received from Burdwan) were also cultivated during the past year. Of these, thirteen varieties have been given up as unsuitable to the locality and the rest have been planted during the current year.

5. MISCELLANEOUS EXPERIMENTS.

Deep and shallow tillage.—This experiment was started in 1882 with the object of seeing what the effect of deep and shallow ploughing would be on wheat when no manure was applied. The original scheme of the experiment was, however, defective and was altered in 1901. The present scheme is as follows :—

There are three plots, the area of each of them being one-fourth of an acre, each plot receiving cow-dung at the rate of 100 lbs. nitrogen per acre. The tillage operations are : for plot No. 1, sub-soiling twice, 8″ to 9″ deep, followed by two ploughings with the country plough; for plot No. 2, ploughing twice with the Watt's plough, 5″ deep, followed by two ploughings with the country plough ; for plot No. 3 eight ploughings with the country plough. The only other implement that was used on these plots was the *patah*. The seed was sown with the country plough and the land levelled with the *patah*.

The outturns obtained are as follows :—

Acreage outturn of wheat on plots ploughed in three different ways.

Year.		Plot No. 1, sub-soiled 8″ deep.	Plot No. 2, ploughed 5″ deep.	Plot No. 3, ploughed 4″ deep.
1901		960	813	779
1902		1,692	1,756	1,455
1903	Grain	1,582	1,530	1,617
	Straw	3,218	2,383	2,898

Early and late sowing of Jaunpur maize.—This experiment was started in 1887, having for its object the determination of the effect of early and late sowing on the yield of this maize. The experiment is carried out in three plots, each of 807 square yards. The dates of sowing were 9th June, 17th July, and 6th August. Farm-yard manure was applied at the rate of 200 maunds per acre. The crops of all three plots suffered from deficiency of rainfall in the month of August. The early sown plot suffered less than the intermediate one and the late sown suffered the most and failed to produce grain. The following statement shows the outturn obtained :—

The early and late sowing of maize.

Plot number.	Time of sowing.	Outturn per acre.											
		Average of 1887-88 to 1891-92.	1892-93.	1893-94.	1894-95.	1895-96.	1896-97.	1897-98.	1898-99	1899-1900.	1900-1901.	1901-1902.	1902-1903.
A. C. 1	Early ...	1,551	1,678	1,825	213	553	260	1,532	1,809	1,062	2,418	1,941	1,563
17 A.	Intermediate	1,169	1,928	1,591	276	1,053	1,322	1,132	1,608	716	2,616	1,845	1,020
A. C. 2	Late ...	...	...	...	...	...	...	...	762	282	2,096	1,623	...

Cotton and maize in alternate rows.—Jaunpur maize and Cawnpore Farm variety No. 1 were sown in the rains in alternate rows by dibbling the seeds in holes. The distance of maize was three feet from row to row and one foot from plant to plant, and the same distance for the cotton. The object of the experiment is to ascertain the results of growing these crops simultaneously; the combination of a food crop and a cash crop is obviously desirable, provided the two do not interfere with one another. The following statement shows the outturn obtained per acre :—

Plot No.	Plot area.	Crop.	Yields in lbs.	Remarks.
26 B. 2 & 3	½th acre	Jaunpur maize ...	145	No second crop of cotton.
		Cawnpore Farm variety No. 1	1st crop	
		Fibre	12·5	
		Seed	30	

This was an exceptionally bad year for both maize and cotton.

Raising pedigree maize.—Two varieties, Jaunpur maize and American yellow Dent Field corn, are being cultivated in order to raise pedigree strains; the experiment was started in 1900. The cultivation was generally similar to that adopted in the other maize plots on the Farm. Each year seed is selected from the plants containing the best and most numerous cobs and from these the best seed is collected.

	Outturn.
Jaunpur maize.	
1900	1,980lbs.
1901	4,800 „
1902	2,260 „
Dent Field Corn (American).	
1900	1,445 „
1901	3,060 „
1902	1,720 „

As remarked in other experiments, it was a very bad year for maize.

CHAPTER II.

Reclamation of barren land.

Tree planting.—The deep-*thala* plantations continue under observation. The large plantation at Abbaspur makes no progress. From observations made last year I have no doubt that the quantity of alkali in the soil was much greater

than was supposed when my predecessor selected the locality. The planting had of course to be carried out in the rains when the alkali would not be apparent to the men at work, and many trees appear to have been planted in very alkaline soil. These facts go some way towards explaining the results which differ distinctly from those of former experiments; but independently of them I am inclined to the conclusion that the system of planting requires too minute care to be applied on a large plantation. It is suitable for the small owner or the cultivator who can get a small patch of barren ground; and if *mahuas* can develope fully under the system, it will be a valuable improvement for the eastern half of the provinces; but where work is on a large scale, difficulties of supervision and management are likely to prevent financial success.

The general condition of the small plantations on alkali land at Gursikran continues satisfactory: and this is true also of the plantations on clay at Juhi. The unusual frost did a good deal of damage to the older *mahua* plantations, but most of the affected trees seem to be recovering, and those that escaped the frost have made good progress. Fifty more *mahuas* were planted out last rains, of which all but two have survived their first hot season. Fifty rain trees were also planted, of which only one has died and the others are at present growing well.

Removal of alkali by sub-soil drainage.—The pipes which had silted up in 1901 were relaid in the hot weather of 1902, and worked fairly well throughout the rains and cold weather; unfortunately some misunderstanding occurred owing to which measurements and samples were not taken during the rains; the samples taken during the cold weather have not yet been analysed, so the results must stand over for the next report.

Drainage by perforation.—This work is still in the preliminary stage. A small plot has been perforated with the auger, and the tops of the hole protected with porous tiles to prevent an inrush of mud. We have first to see whether the precautions that have been taken are sufficient to keep the holes from choking.

Removal of alkali by scraping.—The plot has now been scraped four times at a total cost of Rs. 11-6-0 per acre. The soil removed in February and May 1902 contained 5 3 per cent. of soda salts, the carbonate predominating; that removed in November had only 1 per cent. of soda salts. The later scrapings have not yet been analysed.

Burning clay.—The texture of the plot burnt last year shows a marked improvement, and it yielded both kharíf and rabi crops; the area of the plot is too small for any inference to be drawn from the outturns.

Liming clay.—The limed plots show distinct improvement in texture. One which received the light dressing of six tons per acre gave 352lbs. wheat where a kharíf had been ploughed in and 288lbs. wheat where the kharíf had been removed. The more heavily limed plot, eight tons to the acre, was sown with kharíf and gave 160lbs. *juár* with 64lbs. *mandua*. The kharíf season was again particularly bad for work of this kind. An early start is almost essential to proper tillage, but the rains were again late and scanty at the outset; the outturns given cannot therefore be taken as the best of which the land is now capable.

Ploughing in green crops.—Lateness of the rains is even more harmful in this work, as if sowings are delayed either there is nothing to plough in at the proper time or the ploughing is done so late as to injure rather than benefit the following crop. Most of the plots have now been treated for three years, but the results of 1901-1902 are not worth giving; the figures of rabi outturn for the remaining two years are given in the following table. The plots are of equal size, about $\frac{1}{8}$th of an acre. The rabi crop in 1901 was wheat-gram, and in 1903, wheat:—

Plot No.	*Treatment.*	*Outturn of rabi in lbs. per acre.* 1901.	1903.
$\frac{49}{2}$	Hemp ploughed in	400	480
$\frac{49}{1}$	Do. removed	352	144
$\frac{50}{2}$	Do. ploughed in		160 germination bad.
$\frac{50}{1}$	Do. removed		240
$\frac{46}{1}$	Do. and *mandua* ploughed in	480	304

Plot No.	Treatment.	Outturn of rábi in lbs. per acre. 1901.	1903.
46/2	Hemp and *mandua* removed ...	336	128
48/2	Do. *mandua*, and *jaár* ploughed	192	112
48/1	Ditto, ditto removed ...	160	80
47/2	Rice ploughed in	356	64
47/1	Do. removed	160	16

None of the land is yet fit for ordinary cropping; hemp seems to give the best results, though in plot No. 50 there was a defect due to bad germination. The rice plot turns out to be a particularly vile bit of land, and, with very little rice to plough in, gave practically no crop this year. A few years' further trial will show whether the system of ploughing in has the merits which have been claimed for it.

Trials of new plants.—*Cassia auriculata (vide* last year's report) was sown at Juhi in *thalas* and on open ground. The plants in *thalas* are doing very well, those on the open ground fairly well. *Atriplex semibaccata* was sown at Gursikran from seed raised at Cawnpore. The seed did not germinate in alkali soil; a few plants raised in good soil did well until the rains, when they at once began to fall off. There was no defect in the seed as sowings of the same stock at Cawnpore did well. Three other salt bushes, which have succeeded on alkali land in Arizona were also tried, *Atriplex canescens, Atriplex elegans,* and *Atriplex natallii.* A few plants of each were raised; the two former appear to be dying since the beginning of the rains, the last-named is doing rather better. Five species of grasses said to flourish in Arizona were also tried, but none of them germinated. The names under which they were received are *Pappophorum apertum, Pappophorum vaginatum, Eriocloa cuspidata, Sporobolus strictus* and *Boutclooa rotherikii.*

A collection has been made of the saltworts of North India, recommended by the Reporter on Economic Products; these will be tried during the current year.

Hay making.—It was not a good year for hay and the yield at each reserve was only about 15 maunds or little over half a ton per acre. Hay, which had been stacked for a year in the ordinary way, was found to have undergone no deterioration. There is no doubt that the yield could be greatly increased by a moderate dressing of manure, but this process can only be carried out close to large towns where manure is a nuisance. In the country there is not enough for the existing cultivation, and it would be economically unsound to divert any portion of the supply to the *usar.*

CHAPTER III.

Entomological Observations.

The most important work of the year has been done on three of the sugarcane borers, *Scirpophaga auriflua, Chilo simplex,* and *Nonagria inferens.* The observations on these pests will be published separately; they are therefore not recorded here.

The Deputy Director has also recorded the following observations during the year in continuation of those given in Chapter IV of last year's report.

Various crops.—Caterpillar, podborer, eating into the pods of *arhar,* gram and poppy; * *Heliothis Armigera Hübn,* figured in Indian Museum Notes, Volume I, No. 2, plate VI, figure IV, known in America as the "boll worm."

Moths.—These I found of two colours :—

(i) pale brown to reddish brown, (ii) olive green.

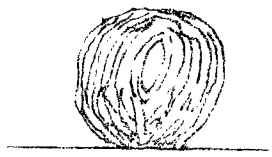
They are stout, about three-fourths of an inch long, wing expanse $1\frac{5}{8}''$, thorax and leg hairy.

Upper surfaces of the wings.—On the fore-wing about the middle is a dark speck and a larger mark sometimes quarter moon shaped or kidney shaped. Beyond the middle of the wing is a transverse band being either simply darker shaded or reddish; and a marginal series of dark specks near the fringed edge. The hind wing is paler with a broad blackish outer border containing a small whitish patch.

* The vernacular names by which this insect is known in different parts of these Provinces are *Bahadurá, Chhedá, Ghonghi, Ili,* and *Sundi.*

Under surfaces of the wings.—The under surface of the speck and mark mentioned above are distinctly black. Towards the outer fimbriated edge of fore and hind wing is a blackish-reddish band, which may be either chiefly blackish and in other cases nearly altogether reddish.

Eggs.—The eggs I found laid singly or two or three together on the upper or lower surfaces of the leaves generally, but sometimes on the pods. They are about $\frac{1}{50}$ of an inch in transverse diameter and under $\frac{3}{4}''$ power can be seen to be marked with vertical ridges. They are globular or sometimes slightly oval in shape and are fairly easily detached from the leaf.



Larva.—Four or five days after being laid the young larvæ hatch out. They are about $\frac{1}{20}$ of an inch long. The head is large and black, with a black collar just behind it on the next segment. The body is green, tip of tail blackish with spots symmetrically arranged as in the adult, and a slender hair arising from each.

The full grown larvæ are fully $1\frac{1}{4}''$ long by $\frac{3}{8}''$ broad. The head is generally green or yellow, the colour markings of the body vary very considerably from an almost plain green, green-yellow or greenish red with faint spots and only dusky lines to those with distinct black spots and regular stripes of different colours, giving a variety in marking and a more ornamental appearance.

The spots or tubercles with a fine hair from each are generally eight on each abdominal segment and are arranged four trapezoidally on the dorsal surface, the anterior pair being nearest together and four laterally, two on each side, one above and one below the spiracles. But on the second and third segments from the head they are arranged in a transverse row and towards the tail end they are either crowded, squarely arranged or the posterior pair are nearest together. The most persistent characters are—(1) a yellowish band along the spiracles sometimes edged with white, or whitish altogether; (2) the arrangement of the tubercles; and (3) under the magnifying glass the upper surface of the body will be seen to be covered with fine whitish wrinkled lines often broken into dots.

The young larvæ first feed on the surface of the leaves and pods, afterwards boring in the latter, sometimes eating the whole of its contents or only partially doing so and then attacking another. In this way much injury is done by a single larva.

The larval stage lasts about 15 to 18 days, but about the time most of the gram and *arhar* had been harvested, the larvæ seemed to be in a hurry to pupate, and did so before they were fully grown, being only 10 days old.

Pupation.—They go into the ground about $2\frac{1}{2}$ to $3\frac{1}{2}$ inches to pupate. The pupa is brown shiny and stout, generally three-fourths of an inch long, segments of the abdomen distinct with two hairs at the tail end $\frac{1}{16}$ of an inch long.

The period of pupation is generally about 18 to 20 days but longer periods occur, one pupating from March 16th to April 27th = 41 days; and three I have still in this pupal state since March 14th, so that it is probable that in this manner the life history is carried on till the next suitable crop appears.

I have not noticed it attacking cotton and maize in this country as in America, but it is mentioned as attacking poppy in Bihar. Volume I, No. 2, page 97 of the Museum Notes and Paddy in Malabar, Madras, Volume IV, No. 2, page 64, as well as gram and *arhar*.

The number of generations on gram and *arhar* here appear to be about three. I first noticed the caterpillars in the fields on March 9th. Some of these were then full grown, so that the attack could not have begun later than about three weeks before.

There appears to be no relation between the colour of the moths and the larvæ, plain green caterpillars coming out reddish brown moths or olive green ones and the more distinctly striped and coloured ones behaving likewise.

Generally speaking applications in the way of poisons can hardly be said to be feasible in this country, and in this case the fact that the caterpillar lives chiefly in the pod and on the seed makes the pest difficult to get at.

There really seems no easy remedy as far as present knowledge goes When the pest appears likely to become serious, picking the affected pods and destroying the larvæ of the first generation would prevent the enormous increase in numbers which would take place under favourable conditions if the early caterpillars become moths and each lays a large number of eggs. But unless the crop appears likely otherwise to be a good one, it will hardly pay for the labour as owing to the growth of the plants, &c., the larvæ are not easily seen.

Various crops.—Beetle injuring brinjal and *kaddu* by eating off the surfaces of the leaves and fruits : they are also found on potatoes, but do these little damage.

Epilachne Viginti-octo-punctata Fabricius, Fam : *Coccinellidæ,* order *Coleoptera.* The beetle is figured in the Indian Museum Notes, Volume III, No. 6, page 9, (1896).

**Beetle.*—The beetle is $\frac{1}{5}''$ to $\frac{1}{4}''$ long and $\frac{3}{16}''$ wide, of a dull or pale red colour, with round black spots on the wing cases varying in size, number, and pattern (sometimes two are lunate).

Eggs.—The eggs are like those of other ladybird beetles, being yellow, torpedo-shaped, about $\frac{1}{16}''$ long, and are laid on end in little groups on the under surface of the leaves.

The eggs are laid in March-April and onwards through the season. One beetle laid 230 eggs, laying from 27 to 80 in a day.

Larva.—The eggs hatch out in four or five days, and the young may be seen in little prickly clusters round the empty eggs at first. The length of larval stage is 24 days. When full grown they are about $\frac{1}{4}''$ long and somewhat oval in shape, colour yellow, covered with forked spines, six on each segment, except the 10th thoracic, which has only four.

Pupa.—The larva attaches itself by the tail end to the leaf when about to pupate. After about 24 hours the larval skin splits and shrinks back, but exposes only about two-thirds of the pupa, which is yellowish at first, becoming olive green with four little whitish points along each edge (breathing pores), short black hairs especially on thorax may be seen under a magnifying glass. After about six days the pupal skin bursts and the beetle comes out with the wings covered at first with a yellow skin which is soon lost. The scientific name means 28 spotted, but I find the number of spots vary considerably, such numbers as 26, 24, 18, 14—12 occurring. These beetles intercopulate freely, and beetles reared from the same lot of eggs vary. Moreover when highly magnified the faint indications of two or four more spots are sometimes visible, thus 26 becomes 28 and 12 may become 16 and so on, but not more than 28 on wing cases. I have also found two beetles with 28 spots on the wings and six on the pronotum (the part between the wing covers and head). They appear in other respects exactly the same as the rest. Ladybird beetles generally do an immense amount of good by eating injurious insects as aphis; but these live wholly on vegetable matter and do a great deal of harm when they occur in large numbers.

As far as I have been able to notice, the life history appears to be carried over the winter in the beetle stage. At that time they do no damage, being few in numbers and they eat little or nothing. About March they begin to copulate and lay eggs and the damage begins with the larvæ which continue to eat when they become beetles, so that in time you have the pest in both stages (and the beetle lives as long as the larva or longer), eating off the green matter of the upper

* Vernacular name—*Lalmakhia.*

and lower surfaces of the leaves until in bad cases little more than the mere skeleton is left, and in brinjal they attack the fruit, doing a great deal of damage when occurring in large numbers. As one generation only takes a little over a month they increase fairly quickly under favourable conditions with each generation *(See the number of eggs laid by a single beetle).*

At the beginning of June I came across a number of the pupa containing a small Hymenopterous parasite. The eggs of this parasite are no doubt laid and hatch out in the larva of the beetle, devour its inside but not before it pupates, the flies escaping from a small circular hole. I have found as many as 16 in one pupa, the latter is naturally dead.

The parasite is minute, length ·07″, wing expanse ·12″, antennæ ·02″, colour a shining metallic green. Antennæ six jointed, except basal joint moniliform pubescent legs rather long; three joints of tarsi whitish, wings almost veinless; abdomen sharply pointed.

In dealing with the beetle and preventing the injury more especially to brinjal, the best way would be to destroy beetles observed on the above plants in the spring before they have time to increase. Even in the later stages I think that picking is the simplest plan in this country, as the beetles are not very active and the larvæ quite easy to catch; moreover, they are easily seen. If any application is applied, it should be with the object of poisoning their food: the following is most suitable:—

White arsenic (commercial) $\frac{1}{4}$lb, lime (unslaked) $\frac{1}{2}$lb. Boil together for half an hour in two gallons of water, dilute up to 25 gallons and spray on to the plants. Such applications as kerosine, tobacco, &c., are quite useless for such hard-bodied insects.

Useful insects.—Ladybird beetles not identified, found on wheat, cotton and other plants attacked by aphis (*plant lice*). The latter injure the plants by sucking out the juices, occurring in enormous numbers under favourable conditions. They are kept largely in check by these beetles and other enemies, which should not be mistaken for injurious insects and blamed for doing damage really done by the small and less observable aphis.

Seven-spotted beetle.—Twenty-eight inches long by two inches wide. Head, body and legs black; wing cases red or yellowish with seven black, somewhat circular, spots three on each separate wing case and the seventh on the inner angle of both. On the prothorax are two whitish spots and two smaller ones on the head, which gives a slightly mask like appearance under a magnifying glass.

Eggs.—These are yellow, torpedo-shaped, about $\frac{1}{16}$ of an inch long laid placed on end in little groups of 8, 12 or as many as 65 in a group on the under surface of the leaves (not noticed on cereals). The eggs I have chiefly found in February and March on cotton and brinjal. They hatch out in six to eight days.

Larva.—The larval period lasts about 10 to 11 days. The larvæ are six-legged, very active, soft bodied and when full grown about $\frac{3}{8}$″ in length and $\frac{1}{8}$″ in width, abdomen long with tail end running to a point. The head, body and legs are black with two or three orange-coloured markings on the back, and the whole upper surface, the head covered with little blunt prominences, each tipped with a short stiff bristle most easily seen with a magnifying glass.

Pupa.—When about to pupate the larva attaches itself by the tail end to the leaf with a yellow secretion. Inside of 24 hours the pupal skin splits down the back and by the movements of the pupa it is worked well back and dries up. The pupa is about $\frac{1}{4}$″ long by $\frac{1}{8}$″ wide with black and orange markings; period of pupation, seven to eight days.

The life history appears to be carried over the winter by the beetle stage, even during the egg-laying period the beetle lives at least two months I should say, if one may judge from those brought indoors as pupa or reared from eggs. They were pairing and laying eggs in February and March, increasing greatly in numbers, being quite conspicuous this year on the wheat and barley, also occurring on other plants attacked by aphis as cotton, brinjal, &c.: towards harvest time they began to disappear, and after this time up to the present (July) only an odd one can be found. They will probably appear again with the aphis on this year's cotton.

Both beetle and larva devour aphis; but the latter is most voracious, eating enormous numbers, and if given insufficient food indoors will attack and devour each other.

Small pinkish ladybird beetle.—Wing cases pale to darker pink or reddish with transverse waved lines and a posterior spot on each. Under surface of the body yellowish. Head and prothorax whitish with a narrow line along the anterior and posterior edges of the latter connected by a short central line and forming with the darker edges of the wing cases where they meet at rest a sort of double T shaped figure, the upper T being the smaller.

Eggs.—These correspond to those of previous beetle mentioned, but are slightly smaller. They hatch out in five or six days. The greatest number of eggs obtained from one beetle were 334, when it accidentally got killed.

Larva.—Larval period lasts from 10 to 11 days usually, but may extend to 14 days. The larvæ are six-legged, active soft-bodied insects and when full grown about $\frac{5}{16}''$ in length and $\frac{1}{16}''$ in width, abdomen long in proportion with tail and running to a point. The head, body, and legs are black, the upper surface of the body has some white and yellow spots, and is covered with black spines, one or two of these being also white or yellow (best seen with the aid of a magnifying glass).

Pupa.—When about to pupate the larva attaches itself as in the former case and larval skin splits inside of 24 hours. The pupa is about $\frac{1}{8}''$ long. Period of pupation six to eight days. The life history apparently corresponds to that of the former one, and though perhaps not eating quite so many aphis as the previous mentioned larger ones, they do a very fair share of the work of keeping aphis in check.

Non-spotted ladybird beetle.—Length about $\frac{1}{4}$ of an inch, breadth $\frac{3}{16}$ of an inch. Head and thorax black, wing cases a darkish red with a black symmetrical marking occupying about two-thirds of each wing case. Not many of these were observed in February, March, and April, and I was unable to find eggs or larvæ: the beetles themselves have disappeared from notice since harvest time.

Dipterous insects.—Not fully identified. They lay their eggs on plants attacked by aphis (plant lice), the larvæ hatching out and eating large numbers of the pest. The genus sysphus is well known in Europe and America as useful in reducing the immense numbers of plant lice which occur on many plants.

The flies resemble somewhat the wasps in form and colouration with their large eyes, hemispherical heads and the rather flattened body ornamented with yellow bands and spots. I have come across two species which have been sent to experts for identification.

The largest of the two is $\frac{5}{16}''$ long, wing expanse $\frac{9}{16}''$. The smaller fly $\frac{3}{16}''$ long, wing expanse $\frac{3}{8}''$. The eggs are cylindrical, elongate, white and are laid singly in groups of plant lice on the under surface of the leaf: on hatching out the larvæ commence at once to prey on the plant lice.

The larva of the larger fly is dirty white, light brown or green with a whitish band down the back, the upper surface of the body is covered with minute spicules. Size $\frac{5}{16}''$ to nearly $\frac{1}{2}''$, when extended, narrow, slightly flattened, tapering to a point towards the head and somewhat truncate behind.

The larva of the smaller fly is about $\frac{1}{4}''$ long and similar in shape, but the spicules are more distinct, the surface of the back red with a longitudinal striped black and yellowish band. Both the larvæ are blind and practically legless, but hold on to the leaf by the tail end. When moving they reach forward with their heads, hold on to the leaf with their mouth parts, leave go behind and drawing the body forward again, catch hold behind, thus they go looping over a leaf in search of plant lice, which on seizing they raise in the air while sucking, throwing away the empty skin when finished. When fully grown the larvæ of both these flies attach themselves to the leaf by the tail end by a glutinous secretion, the larval skin contracting in length and hardening so that the head end which was formerly

pointed becomes round and the tail end previously somewhat truncated becomes slightly pointed. Period of pupation in both eight to nine days. These insects preying on plants lice are themselves attacked by a parasite, which probably lays its egg in the larvæ and the parasite fly comes out of the pupa case instead of the real one.

CHAPTER IV.

MISCELLANEOUS.

1. *Wheat rust.*—The investigations of which the early results were noted in last year's report (Chapter III), have been continued during the year in conjunction with the Cryptogamic Botanist to the Government of India, who, I understand, will publish the joint results. They need not, therefore, be detailed here.

2. *Wheat-breeding.*—Detailed work has continued satisfactorily. Last year was a particularly satisfactory one, as the entire absence of cold weather rains enabled me to ascertain which wheats had drought-resisting characters. Crosses will now be raised from these, and when we get a rusty year we shall be able to decide which of the drought-resisters are least susceptible to rust, and we shall then be on the way to find a wheat suitable for Bundelkhand.

3. *Drought-resisting fodder plants.*—The following notes are given in continuation of those in last year's report:—

Atriplex nummularia.—The single plant that had survived has made tremendous growth and is now nearly five feet high. Another plant, which appears to be *Atriplex halimoides*, has made somewhat similar growth; but it must be remembered that these plants have not had experience of a wet season yet.

Atriplex semibaccata.—This has taken a great step forward and appears likely to acclimatize. But it is a low creeping plant with very little fodder on it, and could not stand the close grazing which prevails in this country. It may, however, be useful for the purpose for which I originally chose it, clothing bare ravines.

Atriplex vesicaria.—Has practically been killed off by heat.

Atriplex leptocarpa.—The few old plants have survived, but made no progress.

Chenopodium auricomum.—Young plants were put out in the cold weather and have done fairly well, though much affected by the heat in May. Their habit is, I fear, too scanty for them to be of any use in this country.

Paspalum dilatatum.—Growth continues very slow, and there is practically no produce.

Rhodes grass.—This grass has got through the hot season very well and is seeding freely.

Sida-retusa.—This small shrub has also done well and many of the plants have seeded. I have not yet ascertained if stock will eat it.

Sterculia diversifolia.—This is so far a complete failure. The few plants that germinated died after a few days.

4. *Nitrogen investigation.*—Our drain gauges have now been constructed and are in working order. I would warn any officers who may contemplate constructing similar gauges, that it is a very difficult and rather expensive piece of work. There are no results to publish as yet.

5. *Sugar boiling.*—The competitive trials which I hoped to hold last year fell through as the leading sugar-boilers at Bareilly had contracts to look after at Delhi. The time was therefore spent in improving our experimental plant and in working at methods of producing the higher grade native sugars. I hope it will be possible to have proper large scale trials made this season.

6. *Well sinking.*—In a note on Irrigation wells published two years ago (Bulletin No. 12 of this department), Mr. E. A. Molony, I.C.S., suggested a method of constructing masonry wells in places where no clay stratum exists. Mr. Molony has now examined this subject further, and has constructed a model which works admirably. Arrangements have been made to construct a well on this principle, Mr. Molony supervising the work and the department paying the cost. The experiment is one of great importance for the provinces.

Digitized with financial assistance from
Hemendra Kothari
on 24 February, 2020

APPENDIX No. 1.—*Amount of rainfall at the Cawnpore Farm in* 1901-1902 *and* 1902-1903.

Month.		1901-1902.		1902-1903.		Average rain-fall of eight years 1891-1899 in inches.
		Rainy days.	Rainfall in inches.	Rainy days.	Rainfall in inches.	
June	First half ...	...	...	1	·14	3·57
	Second half ...	...	...	...	...	
July	First half ...	2	4·66	6	2·45	9·60
	Second half ...	4	2·99	9	4·57	
August	First half ...	8	6·28	4	1·02	13·61
	Second half ...	7	5·39	2	·77	
September	First half ...	2	·79	9	13·125	6·23
	Second half ...	3	5·95	3	·65	
October	First half ...	...	...	...	...	1·73
	Second half ...	...	...	...	...	
November	First half ...	...	...	...	...	·48
	Second half ...	...	...	...	...	
December	First half ...	...	...	...	...	·27
	Second half ...	...	·05	...	...	
January	First half ...	...	·05	...	...	·64
	Second half ...	...	...	...	...	
February	First half ...	...	...	...	...	·50
	Second half ..	1	·17	...	...	
March	First half ...	...	...	...	...	·05
	Second half ...	...	...	...	...	
April	First half ...	...	...	...	...	...
	Second half ...	...	...	...	...	
May	First half ...	1	·55	...	...	·33
	Second half ...	1	·15	...	...	
		29	27·03	34	22·725	